What is claimed is:

1. A control device for an electric motor, comprising:

an inverter circuit connected to a direct-current power source to convert a power from the direct-current power source to an alternating current power, thereby driving the electric motor by the alternating current power;

a control unit for controlling the operation of the inverter circuit on the basis of a target torque;

a superimposing unit for superimposing a superimposed current on a drive current for driving the electric motor, the superimposed current having a frequency different from a frequency of the drive current;

a feature target generating unit for calculating a target value of a feature based on at least one of the length of a long axis of a current vector locus and the length of a short axis thereof, corresponding to the target torque;

a separating unit for separating the superimposed current from a current supplied to the electric motor;

an actual feature detecting unit detecting an actual value of the feature based on at least one of the length of a long axis of a current vector locus of the superimposed current separated by the separating unit and the length of a short axis thereof, the superimposed current having a different frequency from that of the drive current; and

a phase angle detecting unit for detecting a phase angle of the electric motor on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit,

wherein the control unit controls the operation of the inverter circuit on the basis of the phase angle detected by the phase angle detecting unit.

2. The control device for the electric motor of claim 1, wherein

the phase angle detecting unit includes a **d**-axis phase angle detecting unit for detecting a **d**-axis phase angle from the current vector locus of the superimposed current, and

the phase angle detecting unit detects the phase angle by correcting the **d**-axis phase angle detected by the **d**-axis phase angle detecting unit, on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit.

3. The control device for the electric motor of claim 1, wherein

the phase angle detecting unit calculates an angular speed on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit, thereby detecting the phase angle of the electric motor based on the angular speed.

4. The control device for the electric motor of claim 1, wherein the phase angle detecting unit comprises:

a **d**-axis phase angle detecting unit for detecting a **d**-axis phase angle from the current vector locus of the separated superimposed current;

a correcting angle calculating unit for calculating a correcting angle on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit; and

a phase angle correcting unit for correcting the **d**-axis phase angle by

the correcting angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the phase angle corrected by the phase angle correcting unit.

5. The control device for the electric motor of claim 1, wherein the phase angle detecting unit comprises:

a first **d**-axis phase angle detecting unit for detecting a first **d**-axis phase angle from the current vector locus of the separated superimposed current;

a second **d**-axis phase angle detecting unit that detects an angular speed ω on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit and that integrates the detected angular speed ω thereby detecting a second **d**-axis phase angle; and

a switching unit for switching the first **d**-axis phase angle detecting unit and the second **d**-axis phase angle detecting unit to each other thereby outputting either the first **d**-axis phase angle or the second **d**-axis phase angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the first or second phase angle outputted from the switching unit.

6. The control device for the electric motor of claim 1, wherein the phase angle detecting unit comprises:

a **d**-axis phase angle detecting unit for detecting and integrating an angular speed from the current vector locus of the separated superimposed

current thereby detecting a **d**-axis phase angle;

a correcting angle calculating unit for calculating a correcting angle on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature; and

a phase angle correcting unit for correcting the **d**-axis phase angle by the correcting angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the phase angle corrected by the phase angle correcting unit.

7. The control device for the electric motor of claim 1, wherein the phase angle detecting unit comprises:

a first **d**-axis phase angle detecting unit for detecting and integrating an angular speed from the current vector locus of the separated superimposed current thereby detecting a first **d**-axis phase angle;

a second **d**-axis phase angle detecting unit that detects an angular speed ω on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit and that integrates the detected angular speed ω thereby detecting a second **d**-axis phase angle; and

a switching unit for switching the first **d**-axis phase angle detecting unit and the second **d**-axis phase angle detecting unit to each other thereby outputting either the first **d**-axis phase angle or the second **d**-axis phase angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the first or second phase angle outputted from the switching unit.

8. The control device for the electric motor of claim 1, wherein the phase angle detecting unit comprises:

an angular speed detecting unit for detecting an angular speed from the current vector locus of the separated superimposed current;

a correcting angle speed calculating unit for calculating a correcting angle speed on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit;

an angular speed correcting unit for correcting the angular speed by the correcting angle speed; and

a phase angle calculating unit for integrating an output of the angular speed correcting unit thereby calculating a phase angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the phase angle calculated by the phase angle calculating unit.

9. The control device for the electric motor of claim 1, wherein the phase angle detecting unit comprises:

a first angular speed detecting unit for detecting an angular speed from the current vector locus of the separated superimposed current;

a second angular speed detecting unit for detecting an angular speed ω on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit;

a switching unit for switching the first angular speed detecting unit and the second angular speed detecting unit to each other thereby outputting

either the angular speed or the angular speed ω; and

a phase angle calculating unit that integrates an output of the switching unit thereby calculating a phase angle, and

the control unit controls the operation of the inverter circuit on the basis of the phase angle outputted from the phase angle calculating unit.

10. The control device for the electric motor of claim 4, wherein

the phase angle correcting unit corrects the **d**-axis phase angle detected by the **d**-axis phase angle detecting unit only in a high load zone where the drive current of the electric motor is more than a predetermined value.

11. The control device for the electric motor of claim 5, wherein

the switching unit supplies the **d**-axis phase angle detected by the second **d**-axis phase angle detecting unit only in a high load zone where the drive current of the electric motor is more than a predetermined value.

12. The control device for the electric motor of claim 8, wherein

the angular speed correcting unit corrects the angular speed detected by the angular speed detecting unit only in a high load zone where the drive current of the electric motor is more than a predetermined value.

13. The control device for the electric motor of claim 9, wherein

the switching unit outputs the angular speed detected by the second angular speed detecting unit only in a high load zone where the drive current of the electric motor is more than a predetermined value.

14. The control device for the electric motor of claim 1, wherein the phase angle detecting unit detects the phase angle of the electric motor by using, as the target value and the actual value, the product $\mathbf{a} \times \mathbf{b}$ of the length **a** of the long axis and the length **b** of the short axis of the current vector locus.

15. The control device for the electric motor of claim 1, wherein the phase angle detecting unit detects the phase angle of the electric motor by using, as the target value and the actual value, the ratio **b / a** of the length **b** of the short axis to the length **a** of the long axis of the current vector locus.

16. The control device for the electric motor of claim 1, wherein the phase angle detecting unit detects the phase angle of the electric motor by using, as the target value and the actual value, a value obtained by inserting the length **a** of the long axis and the length **b** of the short axis of the current vector locus into an expression of:

$$\sqrt{(a^2 + b^2)} \div (a + b)$$

17. The control device for the electric motor of claim 1, wherein the current vector locus is a locus of a current on α / β -axes.

18. The control device for the electric motor of claim 1, wherein the current vector locus is a locus of a current on **d-q** axes.

19. The control device for the electric motor of claim 1, wherein

the superimposed current is a high-frequency current whose voltage vector locus is a perfect circle,

the high-frequency current is superimposed on the drive current for driving the electric motor, and

the phase angle is detected on the basis of at least one of the length of a long axis of a current vector locus of the high-frequency current and the length of a short axis thereof.

20. A control device for an electric motor, comprising:

an inverter circuit connected to a direct-current power source to convert a power from the direct-current power source to an alternating current power, thereby driving the electric motor by the alternating current power;

a control unit for controlling the operation of the inverter circuit on the basis of a target torque;

a superimposing unit for superimposing a superimposed current on a drive current for driving the electric motor, the superimposed current having a frequency different from a frequency of the drive current;

a feature target generating unit for calculating a target value of a feature based on at least one of the length of a long axis of a voltage vector locus and the length of a short axis thereof, corresponding to the target torque;

a separating unit for separating the superimposed current from a current supplied to the electric motor;

an actual feature detecting unit detecting an actual value of the

feature based on at least one of the length of a long axis of a voltage vector locus of the superimposed current separated by the separating unit and the length of a short axis thereof, the superimposed current having a frequency different from that of the drive current; and

a phase angle detecting unit for detecting a phase angle of the electric motor on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit,

wherein the control unit controls the operation of the inverter circuit on the basis of the phase angle detected by the phase angle detecting unit.

21. The control device for the electric motor of claim 20, wherein

the phase angle detecting unit includes a **d**-axis phase angle detecting unit for detecting a **d**-axis phase angle from the voltage vector locus of the superimposed current, and

the phase angle detecting unit detects the phase angle by correcting the **d**-axis phase angle detected by the **d**-axis phase angle detecting unit, on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit.

22. The control device for the electric motor of claim 20, wherein

the phase angle detecting unit calculates an angular speed on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit, thereby detecting the phase angle of the electric motor based on the calculated angular speed.

23. The control device for the electric motor of claim 20, wherein the phase angle detecting unit comprises:

a **d**-axis phase angle detecting unit for detecting a **d**-axis phase angle from the voltage vector locus of the separated superimposed current;

a correcting angle calculating unit for calculating a correcting angle on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit; and

a phase angle correcting unit for correcting the **d**-axis phase angle by the correcting angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the phase angle corrected by the phase angle correcting unit.

24. The control device for the electric motor of claim 20, wherein the phase angle detecting unit comprises:

a first **d**-axis phase angle detecting unit for detecting a first **d**-axis phase angle from the voltage vector locus of the separated superimposed current;

a second **d**-axis phase angle detecting unit that detects an angular speed ω on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit and that integrates the detected angular speed ω thereby detecting a second **d**-axis phase angle; and

a switching unit for switching the first **d**-axis phase angle detecting unit and the second **d**-axis phase angle detecting unit to each other thereby outputting either the first **d**-axis phase angle or the second **d**-axis phase

angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the first or second phase angle outputted from the switching unit.

25. The control device for the electric motor of claim 20, wherein the phase angle detecting unit comprises:

a **d**-axis phase angle detecting unit for detecting and integrating an angular speed from the voltage vector locus of the separated superimposed current thereby detecting a **d**-axis phase angle;

a correcting angle calculating unit for calculating a correcting angle on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature; and

a phase angle correcting unit for correcting the **d**-axis phase angle by the correcting angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the phase angle corrected by the phase angle correcting unit.

26. The control device for the electric motor of claim 20, wherein the phase angle detecting unit comprises:

a first **d**-axis phase angle detecting unit for detecting and integrating an angular speed from the voltage vector locus of the separated superimposed current thereby detecting a first **d**-axis phase angle;

a second **d**-axis phase angle detecting unit that detects an angular speed ω on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting

unit and that integrates the detected angular speed ω thereby detecting a second **d**-axis phase angle; and

a switching unit for switching the first **d**-axis phase angle detecting unit and the second **d**-axis phase angle detecting unit to each other thereby outputting either the first **d**-axis phase angle or the second **d**-axis phase angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the first or second phase angle outputted from the switching unit.

27. The control device for the electric motor of claim 1, wherein the phase angle detecting unit comprises:

an angular speed detecting unit for detecting an angular speed from the voltage vector locus of the separated superimposed current;

a correcting angle speed calculating unit for calculating a correcting angle speed on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit;

an angular speed correcting unit for correcting the angular speed by the correcting angle speed; and

a phase angle calculating unit for integrating an output of the angular speed correcting unit thereby calculating a phase angle, and

the control unit controls the operation of the inverter circuit on the basis of the phase angle calculated by the phase angle calculating unit.

28. The control device for the electric motor of claim 20, wherein the

phase angle detecting unit comprises:

a first angular speed detecting unit for detecting an angular speed from the voltage vector locus of the separated superimposed current;

a second angular speed detecting unit for detecting an angular speed ω on the basis of the target value calculated by the feature target generating unit and the actual value detected by the actual feature detecting unit;

a switching unit for switching the first angular speed detecting unit and the second angular speed detecting unit to each other thereby outputting either the angular speed or the angular speed ω; and

a phase angle calculating unit that integrates an output of the switching unit thereby calculating a phase angle,

wherein the control unit controls the operation of the inverter circuit on the basis of the phase angle outputted from the phase angle calculating unit.

29. The control device for the electric motor of claim 23, wherein

the phase angle correcting unit corrects the **d**-axis phase angle detected by the **d**-axis phase angle detecting unit only in a high load zone where the drive current of the electric motor is more than a predetermined value.

30. The control device for the electric motor of claim 24, wherein

the switching unit corrects the **d**-axis phase angle detected by the second **d**-axis phase angle detecting unit only in a high load zone where the drive current of the electric motor is more than a predetermined value.

31. The control device for the electric motor of claim 27, wherein

the angular speed correcting unit corrects the angular speed detected by the angular speed detecting unit only in a high load zone where the drive current of the electric motor is more than a predetermined value.

32. The control device for the electric motor of claim 28, wherein

the switching unit outputs the angular speed detected by the second angular speed detecting unit only in a high load zone where the drive current of the electric motor is more than a predetermined value.

33. The control device for the electric motor of claim 20, wherein

the phase angle detecting unit detects the phase angle of the electric motor by using, as the target value and the actual value, the product **a**×**b** of the length **a** of the long axis and the length **b** of the short axis of the voltage vector locus.

34. The control device for the electric motor of claim 20, wherein

the phase angle detecting unit detects the phase angle of the electric motor by using, as the target value and the actual value, the ratio **b** / **a** of the length **b** of the short axis to the length **a** of the long axis of the voltage vector locus.

35. The control device for the electric motor of claim 20, wherein

the phase angle detecting unit detects the phase angle of the electric motor by using, as the target value and the actual value, a value obtained by inserting the length **a** of the long axis and the length **b** of the short axis of

the voltage vector locus into an expression of:

$$\sqrt{(a^2 + b^2)} \div (a + b)$$

36. The control device for the electric motor of claim 20, wherein the voltage vector locus is a locus of a current on α - β axes.

37. The control device for the electric motor of claim 20, wherein the voltage vector locus is a locus of a current on **d-q** axes.

38. The control device for the electric motor of claim 20, wherein

the superimposed current is a high-frequency current whose current vector locus is a perfect circle,

the high-frequency current is superimposed on the drive current for driving the electric motor, and

the **d**-axis phase angle is corrected on the basis of at least one of the length of a long axis of a voltage vector locus of the high-frequency current and the length of a short axis thereof.

39. A control device for an electric motor, comprising:

an inverter circuit connected to a direct-current power source to convert a power from the direct-current power source to an alternating current power, thereby driving the electric motor by the alternating current power;

control means for controlling the operation of the inverter circuit on the basis of a target torque;

superimposing means for superimposing a superimposed current on

a drive current for driving the electric motor, the superimposed current having a frequency different from a frequency of the drive current;

feature target generating means for calculating a target value of a feature based on at least one of the length of a long axis of a current vector locus and the length of a short axis thereof, corresponding to the target torque;

separating means for separating the superimposed current from a current supplied to the electric motor;

actual feature detecting means for detecting an actual value of the feature based on at least one of the length of a long axis of a current vector locus of the superimposed current separated by the separating means and the length of a short axis thereof, the superimposed current having a different frequency from that of the drive current; and

phase angle detecting means for detecting a phase angle of the electric motor on the basis of the target value calculated by the feature target generating means and the actual value detected by the actual feature detecting means,

wherein the control means controls the operation of the inverter circuit on the basis of the phase angle detected by the phase angle detecting unit.

40. A method for controlling an electric motor having an inverter circuit connected to a direct-current power source to convert a power from the direct-current power source to an alternating current power for driving the electric motor, the method comprising:

calculating a target value of a feature based on at least one of the

length of a long axis of a current vector locus and the length of a short axis thereof, corresponding to a target torque for the electric motor;

superimposing a superimposed current on a drive current for driving the electric motor thereby detecting an actual value of the feature based on at least one of the length of a long axis of a current vector locus of the superimposed current and the length of a short axis thereof, the superimposed current having a different frequency from that of the drive current;

detecting a phase angle of the electric motor on the basis of the target value and the actual value; and

controlling the operation of the inverter circuit on the basis of the phase angle.